

# **Use of a Circulation Model to Enhance Predictability of Bioluminescence in the Coastal Ocean**

Igor Shulman  
College of Marine Sciences  
The University of Southern Mississippi  
Mail Code USM COAM  
Stennis Space Center, MS 39529  
phone: (228) 688-3403 fax: (228) 688-7072; e-mail: [shulman@coam.usm.edu](mailto:shulman@coam.usm.edu)

Grant Number: N00014-02-1-0852  
<http://www.coam.usm.edu/ICON>

## **LONG-TERM GOALS**

The long-term objective is to contribute to the development of the components of limited area, open boundary, coastal nowcast/forecast systems that will resolve the time and length scales of the relevant ocean dynamics in shallow coastal environments.

## **OBJECTIVES**

Our objective is to develop the technology and methodology to optimize limited spatial and temporal bioluminescence (BL) sampling for maximum impact on short-term (2-3 days) BL forecasts.

## **APPROACH**

The BL forecasts will be conducted by assimilating limited BL observations into an advective-diffusive tracer model with the velocities and diffusivities from a nested, data-assimilating coastal circulation model of the Monterey Bay area (named the ICON model due to NOPP sponsored project “Innovative Coastal-Ocean Observing Network” (ICON)) and with a finer-resolution sub model of the ICON model (frsICON) around the upwelling front at the north of the Monterey Bay (Shulman et al., 2002a, Shulman et al., 2002b). Data sets to be used include ongoing observational efforts by Dr. Haddock in Monterey Bay, as well as the AOSN-II experiment planned for August 2003. A significant enhancement to the hydrodynamic model will be the inclusion of tidal forcing.

Modeling activities will be undertaken in conjunction with the high-resolution bioluminescence observational program being conducted by Dr. Haddock in the Monterey Bay area. During each of the three oceanographic seasons typical in this area, Dr. Haddock will use AUVs to measure BL along 5 radial sections covering the Bay over 6 subsequent days (one section will be sampled twice). These observations will be made during three typical oceanographic seasons through two full sets of seasonal cycles. A planned AUV upgrade will provide velocity data, as well as the temperature, salinity, and BL data. This coincident sampling of the BL and physical variables will allow crucial testing of our techniques, which would not be possible without data sets collected on comparable spatial and temporal scales.

Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>30 SEP 2002</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-2002 to 00-00-2002</b>	
4. TITLE AND SUBTITLE <b>Use of a Circulation Model to Enhance Predictability of Bioluminescence in the Coastal Ocean</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>College of Marine Sciences,The University of Southern Mississippi,,Mail Code USM COAM,,Stennis Space Center,,MS, 39529</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT <b>The long-term objective is to contribute to the development of the components of limited area, open boundary, coastal nowcast/forecast systems that will resolve the time and length scales of the relevant ocean dynamics in shallow coastal environments.</b>					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>4</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

Research is being performed in collaboration with Drs. D. McGillicuddy of WHOI; S. Haddock of MBARI; J. Paduan and L. Rosenfeld of NPS; and Dr. J. Kindle's group at NRL.

## **WORK COMPLETED and RESULTS**

This is a new effort begun in July of 2002.

We are in the process of: 1) analyzing atmospheric and hydrodynamic conditions during the first MBARI cruise in August of 2002; and 2) acquiring necessary input data for the circulation model runs during the period of the first cruise.

The proposed research is a part of the ONR "Autonomous Ocean Sampling Network" (AOSN-II) adaptive sampling study in the Monterey Bay. We have been participating in the development of the objectives as well as in the design and planning of the AOSN II experiment. The ICON model outputs were provided to the AOSN II group.

## **IMPACT/APPLICATIONS**

Prediction of the bioluminescence potential is critical for numerous naval operations, including preventing detection of covert operations involving submarines, Swimmer Delivery Vehicles and AUVs, and – conversely - in aiding detection of enemy incursions. In most cases, only limited *in situ* sampling of BL is possible immediately prior to, or during, these activities. The proposed research will provide technology and recommendations for optimizing this sampling and for use of these limited BL observations for short-term BL forecasts by tracers with the use of circulation model predictions.

## **TRANSITIONS**

ICON model output will be used by the AOSN II group for testing optimal sampling schemes and for optimizing the trajectories and control theory used for AUVs.

## **RELATED PROJECTS**

ONR, "Autonomous Ocean Sampling Network II (AOSN II) Experiment".

Coordination with a joint effort by the Harvard, MBARI, WHOI, NPS, Princeton, CalTech, JPL, NRL, and USM groups in designing and building an Adaptive Coupled Observation/Modeling Prediction System in the Monterey Bay.

ONR, "High-Resolution Measurements of Coastal Bioluminescence; Improving Short-Term Predictability Across Seasons", MBARI.

Modeling activities will be undertaken in conjunction with the high-resolution bioluminescence observational program being conducted by Dr. Haddock in the Monterey Bay area.

NRL, "Coupled Biophysical-Dynamics Across the Littoral Transition (CoBALT)."

CoBALT Pacific West Coast model predictions and COAMPS products are used for open-boundary and surface forcing in the Monterey Bay area models (ICON and frsICON models).

## REFERENCES

Shulman, I., C.-R. Wu, J.K. Lewis, J.D. Paduan, L.K. Rosenfeld, J.C. Kindle, S.R. Ramp, C.A. Collins, 2002a. High Resolution Modeling and Data Assimilation in the Monterey Bay Area. *Continental Shelf Research*, **22**, 1129-1151.

Shulman, I., S.H.D. Haddock, D.J. McGillicuddy, J.D. Paduan, and W.P. Bissett, 2002c: Numerical Modeling of Bioluminescence Distributions in the Coastal Ocean. Submitted to the *Journal of Atmospheric and Oceanic Technology*.